CLAIMS

1. A method of manufacturing a semiconductor film separated from a seed substrate, comprising:

a separation layer forming step of hetero-epitaxially growing a separation layer on the seed substrate;

a semiconductor film forming step of forming a semiconductor film on the separation layer; and

a separation step of separating, by using the separation layer, the semiconductor film from a composite member formed in the semiconductor film forming step.

2. The method according to claim 1, wherein in the separation layer forming step, a layer configured to generate a strain energy in the separation layer, and/or an interface between the separation layer and the semiconductor film, and/or the interface between the separation layer and the seed substrate is formed as the separation layer.

3. The method according to claim 1, wherein in the separation layer forming step, the separation layer is formed by using a material having a lattice constant and/or thermal expansion coefficient different from the seed substrate.

4. The method according to claim 1, wherein in the separation step, the semiconductor film is separated

from the composite member by applying a force to the composite member.

5. The method according to claim 1, wherein the seed substrate has a single-crystal structure.

6. The method according to claim 1, wherein in the separation layer forming step, a separation layer having a crystal structure is formed.

7. The method according to claim 1, wherein in the separation layer forming step, a separation layer having a microcrystal structure is formed.

8. The method according to claim 1, wherein in the semiconductor film forming step, a semiconductor film having a single-crystal structure is formed.

9. The method according to claim 1, wherein in the separation step, a crack spreading in a planar direction of the seed substrate is generated in the separation layer, and/or an interface between the separation layer and the semiconductor film, and/or the interface between the separation layer and the seed substrate to separate the semiconductor film from the composite member.

10. The method according to claim 1, wherein the seed substrate is made of a materiel selected from the group consisting of Al_2O_3, SiC, GaAs, InP, Ge, and Si.

11. The method according to claim 1, wherein in the separation layer forming step, a separation layer made of a compound semiconductor is formed.

12. The method according to claim 1, wherein in the separation layer forming step, a separation layer made of a material selected from the group consisting of GaN, InGaN, AlGaN, AlN, AlAs, AlGaAs, InGaAs, InAlAs, InGaAlP, InGaAsP, and InGaP is formed.

13. The method according to claim 1, wherein in the semiconductor film forming step, a semiconductor film made of a material selected from the group consisting of GaN, GaAs, InP, AlGaAs, InGaN, AlGaN, AlN, AlAs, InGaAs, InAlAs, InGaAlP, InGaAsP, and InGaP is formed.

14. The method according to claim 1, wherein the semiconductor film forming step, the semiconductor film is formed by epitaxial growth.

15. The method according to claim 1, wherein the seed substrate is made of one of Al_2O_3 and SiC, and the separation layer is made of a material selected from the group consisting of GaN, InGaN, AlGaN, and AlN.

16. The method according to claim 1, wherein the seed substrate is made of a material selected from the group consisting of GaAs, InP, and Ge, and the separation layer is made of a material selected from the group consisting of AlGaAs, InGaAs, InAlAs, InGaAlP, InGaAsP, and InGaP.

17. The method according to claim 1, further comprising a step of forming, between the seed substrate and the separation layer, a separation assisting layer by using a material to be selectively

etched with respect to the substrate and the separation layer.

18. The method according to claim 1, further comprising a step of forming a separation assisting layer between the seed substrate and the separation layer, the separation assisting layer containing Al in a larger amount than layers in contact with the separation assisting layer.

19. The method according to claim 1, further comprising a step of forming a separation assisting layer between the seed substrate and the separation layer, the separation assisting layer being made of a material which satisfies $Al_xGa_{1-x}As$ ($x > 0.95$).

20. The method according to claim 17, further comprising, before the separation step, a step of etching a periphery of the separation assisting layer.

21. The method according to claim 20, wherein in the separation step, a fluid is blown to or near the separation layer on a side surface of the composite member.

22. The method according to claim 1, further comprising, after the semiconductor film forming step before the separation step, a bonding step of bonding the seed substrate with the separation layer and the semiconductor film to a handle substrate while setting the separation layer inside,

wherein in the separation step, the semiconductor

film is separated, together with the handle substrate by using the separation layer, from the composite member formed in the bonding step.

23. The method according to claim 1, further comprising a device forming step of forming a semiconductor device on the semiconductor film.

24. The method according to claim 23, wherein the device forming step is executed before the bonding step.

25. The method according to claim 23, wherein the device forming step is executed after the separation step.

26. The method according to claim 1, wherein another semiconductor film is manufactured by further executing the separation layer forming step and subsequent steps by using the seed substrate remaining after the separation step as a raw material.

27. A method of manufacturing a substrate having a semiconductor film, comprising:

a separation layer forming step of hetero-epitaxially growing a separation layer on a seed substrate;

a semiconductor film forming step of forming a semiconductor film on the separation layer;

a bonding step of bonding the seed substrate with the separation layer and the semiconductor film to a handle substrate while setting the separation layer

inside; and

a separation step of separating the semiconductor film, together with the handle substrate by using the separation layer, from a composite member formed in the bonding step to obtain a substrate having the semiconductor film on the handle substrate.

28. The method according to claim 27, further comprising a device forming step of forming a semiconductor device in the semiconductor film.

29. The method according to claim 28, wherein the device forming step is executed before the bonding step.

30. The method according to claim 28, wherein the device forming step is executed after the separation step.

31. The method according to claim 28, wherein the semiconductor device includes one of a light-emitting diode and a laser.